

GCSE (9–1)

Chemistry A (Gateway Science)

J248/04: Paper 4 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for November 2020

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Annotations

Annotation	Meaning
✓	Correct response
✗	Incorrect response
^	Omission mark
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	Ignore

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Subject-specific Marking Instructions**INTRODUCTION**

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9-1) in Chemistry:

	Assessment Objective
AO1	Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

Question	Answer	Marks	AO element	Guidance
1	C ✓	1	2.2	
2	D ✓	1	2.2	
3	A ✓	1	1.1	
4	B ✓	1	1.1	
5	C ✓	1	1.1	
6	A ✓	1	1.1	
7	D ✓	1	2.1	
8	B ✓	1	2.2	
9	B ✓	1	1.1	
10	B ✓	1	2.2	
11	B ✓	1	1.1	
12	D ✓	1	1.1	
13	C ✓	1	1.1	
14	D ✓	1	1.1	
15	C ✓	1	2.2	

For answers to Section A if an answer box is blank ALLOW correct indication of answer e.g. circled or underlined.

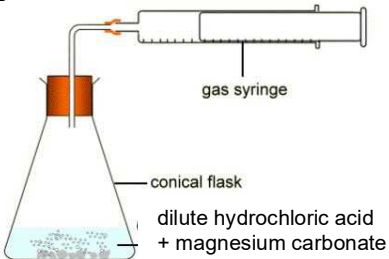
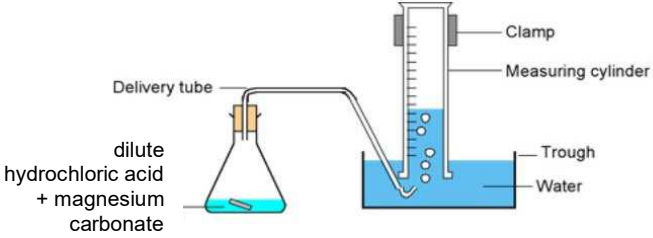
Question		Answer	Marks	AO element	Guidance
16	(a)	<p>Any three from: (Metal wire is made of metal because) it is a good conductor (of electricity) ✓ it is flexible ✓</p> <p>(Metal wire is coated with a polymer because) it is an insulator or poor conductor (of electricity) ✓ it is flexible ✓</p>	3	3.2a	IGNORE references to other properties
	(b)	<p>Any one from: Aluminium is higher in the reactivity series than carbon / aluminium is more reactive than carbon / ORA ✓</p> <p>Carbon cannot displace aluminium (from bauxite) / bauxite cannot be reduced by carbon ✓</p>	1	2.2	<p>Assume unqualified answers refer to aluminium</p> <p>IGNORE aluminium is very reactive Answers must be comparative</p> <p>ALLOW bauxite does not react with carbon</p>
	(c)	(i)			
		<p>Any two from: Aluminium (metal) is sorted from other metals / materials ✓</p> <p>Idea that aluminium/metal is shredded or crushed into smaller pieces ready for processing ✓</p> <p>Idea that aluminium/metal is melted (by heating) ✓</p> <p>Molten aluminium/metal is poured into moulds ✓</p>	2	1.1	<p>DO NOT ALLOW references to electrolysis</p> <p>ALLOW idea of cooling to form a solid (again)</p>

Question	Answer	Marks	AO element	Guidance
	<p>(ii) Any three from: Idea that recycling aluminium saves energy (compared to extracting aluminium from bauxite) / ORA ✓ Idea that recycling makes more aluminium (than extraction from bauxite) ✓ Aluminium isn't wasted ✓ Use of data to back up either idea ✓ Idea of finite resource ✓ Idea of aluminium not being biodegradable, so recycling reduces landfill ✓ Idea that recycling aluminium produces less waste material (than extraction from bauxite) / ORA ✓ Idea that recycling aluminium produces less greenhouse gas emissions (than extraction from bauxite) / ORA ✓</p>	3	3.2b	<p>IGNORE just quoting numbers; answer must be comparative IGNORE references to cost</p> <p>ALLOW idea that recycling aluminium uses less raw materials</p>

Question		Answer	Marks	AO element	Guidance
17	(a)	<p>Any two from:</p> <p>Fertilisers increase crop yields ✓</p> <p>Idea that growing populations mean that farmers need to grow more crops ✓</p> <p>Idea that fertilisers provide essential elements for crops ✓</p> <p>Idea that the quality of crops will be reduced without fertilisers ✓</p> <p>Idea that fertilisers allow farmers to use the same land over and over again ✓</p>	2	1.1	<p>IGNORE just references to good / increased / faster growth</p> <p>ALLOW specific examples of essential elements, ie nitrogen / potassium / phosphorus</p> <p>IGNORE references to providing nutrients / minerals</p> <p>ALLOW specific example of reduced crop quality eg poor (root or fruit) growth / discoloured or yellow leaves etc</p> <p>IGNORE idea of controlling pests</p>
	(b)	<p>Sulfur (for sulfur trioxide) ✓</p> <p>Air (for nitrogen) ✓</p>	2	1.1	IGNORE sulfur dioxide
	(c)	(i) <p>FIRST CHECK THE ANSWER ON ANSWER LINE</p> <p>If answer = 120 (tonnes) award 3 marks</p> <p>M_r of $\text{NH}_3 = 17$ AND M_r of $\text{NH}_4\text{NO}_3 = 80$ ✓</p> <p>Mass of ammonium nitrate = $\frac{80}{17} \times 25.5 / 1.5 \times 80$ ✓</p> <p>= 120 (tonnes) ✓</p>	3	2.1	ALLOW ECF from incorrect RMMs

Question		Answer	Marks	AO element	Guidance
	(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 10(g) award 2 marks Actual mass = $\frac{80 \times 12.5}{100}$ ✓ = 10 (g) ✓	2	1.2 2.2	ALLOW % yield = (am ÷ pm) x 100 OR 80 = (am ÷ 12.5) x 100 for 1 mark if no other mark awarded

Question		Answer	Marks	AO element	Guidance
18	(a)	$2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$ Formulae ✓ Balancing ✓	2	1.1 2.1	ALLOW any correct multiple, including fractions DO NOT ALLOW and / & instead of '+' balancing mark is dependent on the correct formulae but ALLOW 1 mark for a balanced equation with a minor error in subscripts / formulae eg $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$
	(b)	(Sodium atom) loses an electron / Oxidation is loss of electrons ✓	1	1.1	
	(c)	Any two from: <u>Outer electron</u> in rubidium is further from the nucleus / ORA ✓ Idea that attraction of rubidium's nucleus for <u>outer electron</u> is less / ORA ✓ <u>Outer electron</u> in rubidium is lost more easily / ORA ✓	2	1.1	Assume unqualified answer refers to rubidium ALLOW <u>outer electron</u> in higher energy level / shell ALLOW more shielding in rubidium IGNORE idea that outer electron is lost more quickly Reference to outer electron needed at least once

Question	Answer	Marks	AO element	Guidance	
19	(a)	<p>Use of gas syringe / upturned measuring cylinder / burette to collect gas over water ✓</p> <p>Apparatus will work ✓ eg</p>  <p>OR</p>  <p>And any three from:</p> <ul style="list-style-type: none"> Measure known volume of acid ✓ Add known mass of magnesium carbonate ✓ Measure volume of gas every 30 seconds ✓ Repeat with different concentrations of acid ✓ Repeat using same temperature ✓ 	5	3.3a	<p>ALLOW idea of same volume of acid in each experiment</p> <p>ALLOW idea of same mass of magnesium carbonate in each experiment</p> <p>ALLOW Measure volume of gas at any sensible time interval</p> <p>ALLOW just the idea of measuring the time taken for a fixed volume of gas to be produced or the volume of gas produced in a fixed time</p> <p>IGNORE measure the time taken for the reaction to finish</p>

Question		Answer	Marks	AO element	Guidance
	(b) (i)	<p>Linear scale on both x and y axes ✓</p> <p>All points plotted correctly scores 2 marks BUT 3 or 4 points plotted correctly scores 1 mark</p> <p>Line of best fit through points ✓</p>	4	3 x 2.2 1.2	<p>ALLOW ± ½ square NB Check that 7.0×10^{-3} is plotted as 0.7×10^{-2}</p>
	(ii)	(Rate of reaction) increases ✓	1	3.1a	
	(iii)	<p>Idea that acid particles move faster / particles have more energy ✓</p> <p>Idea of increased collision frequency (between acid and thiosulfate) ✓</p> <p>Idea of more successful collisions / collisions (between acid and thiosulfate) are more energetic / more particles have the activation energy ✓</p>	3	2.2	<p>IGNORE references to 'faster' collisions</p> <p>IGNORE just 'more collisions'</p>

Question			Answer	Marks	AO element	Guidance
20	(a)	(i)	A and D ✓	1	2.1	Both required for the mark
		(ii)	<p>Any two from: Have the same general formula / both have the formula C_nH_{2n+2} ✓</p> <p>Idea that they differ from each other by CH_2 ✓</p> <p>Both hydrocarbons with only single bonds / both saturated hydrocarbons ✓</p>	2	1.1	<p>ALLOW have similar chemical properties ALLOW show trends in physical properties</p> <p>ALLOW both hydrocarbons with no double bonds ALLOW A and D have the same functional group or no functional group / B and C have different functional groups (from A and D) ALLOW both (A and D) are alkanes / C is an alkene and B is a carboxylic acid</p>
	(b)	(i)	$\left(\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{---} \text{C} \text{---} \text{C} \text{---} \\ \quad \\ \text{H} \quad \text{CH}_3 \end{array} \right)_n$ <p>Correct structure ✓ Brackets and 'n' ✓</p>	2	2.1	<p>ALLOW structure of $-CH_3$ group shown ALLOW round or square brackets</p> <p>Second marking point is dependent on correct structure</p>

Question	Answer	Marks	AO element	Guidance
	<p>(ii) Any one from: Idea that in addition polymerisation monomers react together to form one large molecule/polymer whereas in condensation polymerisation one large molecule and a smaller molecule is formed ✓</p> <p>A monomer (molecule) for addition polymerisation has one functional group whereas a monomer (molecule) for condensation polymerisation requires two different functional groups ✓</p> <p>Addition polymerisation requires a catalyst (whereas condensation polymerisation can happen without a catalyst) / ORA ✓</p> <p>Addition polymerisation requires high temperature (whereas condensation polymerisation can happen at room temperature) / ORA ✓</p> <p>Addition polymerisation requires high pressure (whereas condensation polymerisation can happen at atmospheric pressure) / ORA ✓</p>	1	1.1	<p>ALLOW condensation polymerisation produces water (whereas addition polymerisation does not) ALLOW idea that addition polymerisation makes one product (whereas condensation polymerisation makes two products) / ORA</p> <p>ALLOW addition polymerisation requires (a monomer) with a C=C, but condensation polymerisation requires a -NH₂ group and a -COOH group</p>

Question	Answer	Marks	AO element	Guidance
(c)*	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p>Level 3 (5–6 marks) Describes tests, the results, and identifies each of the three samples AND Includes correct balanced symbol equations for the reactions which occur.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) Describes tests, the results, and identifies each of the three samples</p> <p>OR Describes a test and the result, to identify one of the three samples and attempts to identify the other two AND Includes a balanced symbol equation for the reaction which occurs.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p>	6	3 x 1.2 3 x 2.2	<p>AO1 Knowledge and understanding of alkanes, alkenes and acids</p> <ul style="list-style-type: none"> Alkanes do not react with bromine water Alkenes react with bromine water / bromine water is decolourised Acids react with carbonates to give off carbon dioxide / fizzing observed <p>AO2 Application and knowledge of tests and results</p> <ul style="list-style-type: none"> Add sodium carbonate (or any suitable carbonate) Ethanoic acid effervesces Pentane and pentene do not effervesce ALLOW other suitable reactions, eg addition of a metal; ethanoic acid effervesces ALLOW use of universal indicator to identify ethanoic acid Add bromine water to separate samples of pentane and pentene and shake With pentene bromine water changes from orange to colourless / bromine water is decolourised With pentane and ethanoic acid bromine water stays orange <p>AO2.1 Application of knowledge and understanding to produce balanced symbol equations</p> $2\text{CH}_3\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{CH}_3\text{COONa} + \text{CO}_2 + \text{H}_2\text{O}$ $\text{C}_5\text{H}_{10} + \text{Br}_2 \rightarrow \text{C}_5\text{H}_{10}\text{Br}_2$

Question	Answer	Marks	AO element	Guidance
	<p>Level 1 (1–2 marks) Describes a test and the result, to identify one of the three samples.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks <i>No response or no response worthy of credit.</i></p>			

Question		Answer	Marks	AO element	Guidance
21	(a)	<p>Any one from: Use a single indicator / named single indicator eg methyl orange / phenolphthalein (instead of universal indicator) ✓ Idea that universal indicator does not give a sudden colour change / universal indicator gives a continuous colour change / ORA ✓</p> <p>OR</p> <p>Fill the burette exactly to the 0.00 cm³ line ✓ Idea that this will give accurate volume of acid ✓</p> <p>OR</p> <p>Idea of adding acid to the alkali <u>slowly</u> or <u>dropwise</u> (near the end point) ✓ Idea that indicator should change colour on addition of one drop (of acid) ✓</p> <p>OR</p> <p>Idea of swirling the alkali while adding the acid ✓ To ensure mixing of acid and alkali / AW ✓</p> <p>OR</p> <p>Use a white tile under the conical flask ✓ To see the colour change easily / clearly ✓</p> <p>OR</p> <p>Repeat the experiment <u>until concordant or consistent results are obtained</u> ✓ To obtain a more accurate titre / AW ✓</p> <p>OR</p> <p>Idea of doing a rough titration ✓ As this will give you an idea of the endpoint ✓</p>	2	3.3b	<p>Explanation must be linked to improvement</p> <p>ALLOW idea of using a pH probe or pH meter to give a more accurate indication of when neutralisation occurs</p> <p>ALLOW idea of missing the end point</p> <p>ALLOW two improvements, with no explanation, for 1 mark if no explanations given</p>

Question		Answer	Marks	AO element	Guidance
	(b) (i)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 23.65 (cm³) award 2 marks</p> <p>Use of volume of acid from titrations 2, 3 & 4 / Use of 23.60, 23.70 & 23.65 ✓</p> <p>Accurate volume of acid = 23.65 (cm³) ✓</p>	2	2.2	<p>DO NOT ALLOW 23.7 (cm³)</p> <p>ALLOW 1 mark for average calculated using all results, ie 24.18 / 24.175 (cm³) but DO NOT ALLOW 24.2 (cm³)</p>
	(b) (ii)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.106 (mol/dm³) award 4 marks</p> <p>moles of alkali = $\frac{0.200 \times 25.0}{1000} / 0.200 \times 0.0250 /$ $0.005 / 5.0 \times 10^{-3}$ ✓</p> <p>moles of acid = $\frac{0.005}{2} = 0.0025 / 2.5 \times 10^{-3}$ ✓</p> <p>concentration of acid = $\frac{0.0025}{0.02365} / \frac{0.0025 \times 1000}{23.65} /$ $\frac{2.5 \times 10^{-3}}{0.02365} / \frac{2.5 \times 10^{-3} \times 1000}{23.65} /$ 0.1057 (mol/dm³) ✓</p> <p>concentration = 0.106 (mol/dm³) (3 sig. figs) ✓</p>	4	<p>3x 2.2</p> <p>1.2</p>	<p>ALLOW ECF from moles of alkali</p> <p>ALLOW ECF from average titre in (b)(i)</p> <p>ALLOW ECF from moles of acid i.e. conc = $\frac{\text{moles}}{0.02365}$ or $\frac{\text{moles} \times 1000}{23.65}$</p>

Question		Answer	Marks	AO element	Guidance
22	(a)	C most reactive A D B least reactive correct order – 2 marks C as most reactive and B as least – 1 mark	2	3.2b	
	(b) (i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = $0.00125 / 1.25 \times 10^{-3}$ award 2 marks Moles = $\frac{\text{volume}}{24} / \frac{0.030}{24} / \frac{30}{24,000} \checkmark$ = $0.00125 / 1.25 \times 10^{-3} \checkmark$	2	2.2	ALLOW 1 mark only for $30 \div 24$ or $0.030 \div 24,000$, correctly calculated
	(ii)	$0.0025 / 2.5 \times 10^{-3} \text{ (g)} \checkmark$	1	2.2	unit not needed ALLOW ECF from (b)(i) ie 2 x answer from (b)(i)
	(c)	Moles of chromium = $\frac{10.40}{52.0} = 0.2 \checkmark$ Moles of nickel = $\frac{17.61}{58.7} = 0.3 \checkmark$ Idea that ratio is 2:3 / ratio isn't 1:1 so <u>equation 2</u> \checkmark	3	2.2	ALLOW other methods of calculation eg 10.40g of chromium forms $\frac{10.40}{52.0} \times 58.7$ = 11.74g nickel $\frac{11.74}{3} \times 2 = 17.61\text{g}$ of nickel So, equation 2 ALLOW answers that show equation 1 is not correct Third marking point is dependent on correct mathematical reasoning

Question		Answer	Marks	AO element	Guidance
	(d) (i)	<p>Any two from: (Bioleaching is) cheaper or uses less energy (than traditional mining) ✓</p> <p>Idea that (bioleaching) allows copper to be extracted from low-grade ores ✓</p> <p>Bacteria used occur naturally / bacteria do not need any special treatment ✓</p> <p>(Bioleaching) does not release harmful sulfur dioxide (into the atmosphere) ✓</p> <p>Idea that (bioleaching) does not lead to destruction of the landscape like mining ✓</p>	2	1.1	<p>IGNORE bioleaching is safer</p> <p>IGNORE less harmful to the environment, unless qualified</p>
	(ii)	<p>(Sulfuric acid) may escape into water supplies /</p> <p>(Sulfuric acid) may escape into the soil ✓</p>	1	1.1	<p>ALLOW an effect of acid escaping into soil eg changes pH of soil / makes soil acidic / stops plants growing / damage ecosystems</p> <p>ALLOW sulfuric acid can kill wildlife</p> <p>IGNORE references to acid rain</p>

Question		Answer	Marks	AO element	Guidance
23	(a)	<p>Idea that both carbon dioxide levels and variation in air temperature shows an increasing trend ✓</p> <p>(Therefore) data suggests that carbon dioxide emissions are linked to global warming ✓</p> <p>OR</p> <p>Idea that carbon dioxide levels have increased steadily but variation in air temperature has fluctuated ✓</p> <p>(Therefore) data does not support a link between carbon dioxide emissions and global warming ✓</p>	2	2 x 3.1b	<p>Evidence and conclusion must be linked</p> <p>ALLOW there is a positive correlation (between carbon dioxide levels and variation in air temperature)</p>
	(b)	<p>Any three from:</p> <p>Idea that energy transferred by radiation from the Sun warms up the Earth's surface ✓</p> <p>Idea that infrared radiation is emitted by the Earth's surface ✓</p> <p>Idea that some infrared radiation goes directly into space ✓</p> <p>Idea that greenhouse gases absorb (some) infrared radiation (radiated by the Earth's surface) ✓</p> <p>Idea that greenhouse gas molecules emit infrared radiation (in all directions), warming the Earth's surface / atmosphere ✓</p>	3	1.1	<p>DO NOT ALLOW references to the ozone layer</p> <p>ALLOW energy instead of infrared radiation throughout</p> <p>IGNORE idea of trapping infrared radiation</p> <p>ALLOW named greenhouse gases eg carbon dioxide / methane</p>

Question		Answer	Marks	AO element	Guidance
	(c) (i)	Any one from: Burning fossil fuels ✓ Deforestation ✓ Intensive use of fertilisers (by farmers) ✓ Cement manufacture ✓	1	1.1	ALLOW example of burning fossil fuels
	(ii)	Any two from: Global warming / increased temperature of Earth's atmosphere ✓ Melting ice caps ✓ Rising sea levels ✓ Altered weather patterns / extreme weather events ✓ Flooding ✓ Increasing ocean acidity ✓	2	1.1	ALLOW climate change

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